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December 2002, revised December 2003

Open-File Report 2004-1036

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
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U.S. Geological Survey, Reston, Virginia: 2004
Revised and reprinted: 2003

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Chapter 6

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Chapter 6. Waterbird Chronology and Habitat Use of Lisbon Bottom During Spring Migration 1999

James F. Fairchild and Linda C. Sappington

Abstract

The Lisbon Bottom Tract of the Big Muddy National Fish and Wildlife Refuge consists of an 875 ha land parcel located within a loop bend on the Lower Missouri River near Glasgow, MO. Lisbon Bottom was purchased in 1995 by the U.S. Fish and Wildlife Service to partially offset historic, cumulative losses of fish and wildlife habitat along the Lower Missouri River. Lisbon Bottom is passively managed (for example, minimal vegetative control or hydrologic management) to allow the area to evolve in a natural ecological trajectory. Lisbon Bottom is seasonally flooded by waters from the Missouri River, the Lisbon Chute, rainfall, and upland tributary inflows. Thus, Lisbon Bottom is an excellent opportunity to evaluate the biological responses of a large river flood plain in relation to localized, natural hydrologic conditions.

Missouri River flood-plain habitats are important migratory corridors for numerous waterbirds including ducks, geese, herons, and shorebirds. We surveyed the chronology of waterbird use of Lisbon Bottom over a 10-week period from mid-March to late May of 1999 to assess the distribution of waterbirds among habitats in relation to hydrologic condition. Waterbird surveys were conducted twice weekly at daybreak. The Lisbon Chute was observed from four points for 10 minutes each and the river was observed from two points for 10 minutes each. Additional 10-min surveys were conducted on 25 flood-plain wetlands distributed across 4 geomorphic basins: Upper, Valley Wall, Middle, and Lower. Thirty-one species of waterbirds, totaling 1517 individuals, were observed over the 10-wk period. The waterbird community was composed of ducks (1025), geese (203), herons (85), shorebirds (79), coots (63), cormorants (34), gulls (11), mergansers (8), terns (3), kingfishers (3) sora rails (2), and a grebe (1). Blue-winged teal were the most abundant duck followed by lesser scaup, wood ducks, and mallards. Scaup and mallards were dominant during the pre-flood period of March 15-April 15, whereas blue-winged teal use overlapped the flood period of April 16–May 18. Chronology of use of Lisbon Bottom was primarily related to spring migration of each species. A wide diversity of waterbirds was observed in the chute (20 species) and main river habitats (13 species). Highest species richness (23 species) occurred on flood-plain wetlands; in addition, flood-plain wetlands were occupied for a longer period of time than the river or chute habitats. There was a significant difference among basin areas in terms of total waterbirds and total number of ducks; however, there was no relationship between species richness and basin location. Wood ducks, mallards, and blue-winged teal had a preference for wetlands within the Valley Wall Basin compared to the Upper, Middle, or Lower Basins. The high bird use of the Valley Wall Basin (primarily Wetlands 11 and 12) may be due to the shallow, persistent moisture conditions associated with inflows from intermittent streams. These data indicate that wetlands along the valley wall at Lisbon Bottom have unique characteristics that make them attractive for waterbirds. Therefore, land managers may need to prioritize these types of geomorphic features in future land management and acquisition activities. However, subtle differences in landform, vegetation (type, density, diversity, and height), and hydrology (timing, frequency, and duration of

flooding) are highly inter-related and complex and therefore require further study to elucidate causal mechanisms.

Introduction

Missouri lies within a spring migration corridor of current and historical importance to migrating waterbirds that move through the interior of North America to reach breeding and nesting grounds in the northern U.S. and Canada (Bellrose, 1974). During springtime numerous species of waterbirds migrate through Missouri and use the Missouri River Bottom and associated wetlands extensively for feeding, resting, and courting. Spring migration is an especially important period in the life history of waterbirds enroute to northern breeding grounds since during this period they require diets high in protein and calcium in order to increase body condition prior to egg laying (Heitmeyer, 1985).

The Lisbon Bottom is an 875 ha tract that lies along an inside channel bend of the Missouri River at river miles 213-218 between Glasgow and Boonville, MO. Lisbon Bottom was purchased in 1995 as part of the newly created Big Muddy National Fish and Wildlife Refuge. A large part of Lisbon Bottom was farmed for corn, soybeans, and wheat prior to major flood events that occurred in 1993 and 1995. These floods, however, greatly altered Lisbon Bottom and resulted in formation of a new cross channel. In addition, numerous basins were scoured in the flood plain and large amounts of silt and sand were deposited. This extensive alteration rendered the property unsuitable for traditional agriculture. Thus, this tract was purchased as part of the Refuge to partly offset historic, cumulative losses of large amounts of riparian habitat that formerly occurred along the Lower Missouri River.

Currently, the Lisbon Bottom Tract is passively managed for wildlife and recreational use. Seasonal flooding of Lisbon Bottom occurs due to rainfall, upland tributary inflow, and flooding from the Missouri River. The lower end of Lisbon Bottom is nearly 5 meters lower than the upstream margin. Lowlands and swales generally back-flood before water tops the natural levees upstream (Jacobson and others, 1999). The ordering of soil textures and hydrology influence the morphology of the wetlands and the entire biological community of the flood plain. Flooding of wetland habitats is highly dynamic and is dependent on localized conditions of soil type, soil moisture, precipitation, and sources of water.

The majority of studies of bird use of the Lower Missouri River have occurred on actively managed sites such as state conservation areas and National Wildlife Refuges. Relatively few studies have been conducted on passively managed sites such as the Lisbon Bottom Tract. Recent studies have documented the species composition of Lisbon Bottom (Humburg and Burke, 1999) and other aquatic habitats of the Lower Missouri River flood plain from a landscape-scale perspective (Humburg and others, 1999). However, there have been no detailed studies of bird use at Lisbon Bottom in relation to habitat suitability and habitat type. In this study we observed the chronology of waterbird use of various habitats at Lisbon Bottom in relation to hydrologic and resource conditions. These studies were conducted to provide managers with insight into the dynamics of spring habitat conditions and how wetland-dependent birds respond to these conditions.

Methods

Waterbird surveys were conducted twice weekly from mid-March through May 1999. Basin classification was made based on spatial location and hydrologic characteristics defined by existing data (for example, Chapter 1; Jacobson and others, 1999). Basin and wetland locations are presented in table 6-1 and figure 6-1. The chute was observed from four points for 10 minutes each and the river was observed from two points for 10 minutes each. Twenty-five additional flood-plain wetlands were observed for 10 minutes along walking survey routes (fig. 6-2). All waterbird surveys were conducted within the first two hours of daylight on each observation day. Wetlands were approached quietly and observed for waterbirds for 10 minutes from thick cover of willow. Care was taken not to disturb birds that might result in movement to other sites and double counting. Water levels in individual wetlands were determined using metered stakes. The chute, river, and some of the scour holes were not observed for waterbirds during the peak of the flood due to difficulty in access and concern for human safety; however, this is not expected to alter the interpretation of the data.

Statistical Analysis

Statistical analysis of biological survey data is often difficult due to the violation of normality of distributions and lack of independence (Green, 1979). However, use of exploratory statistics is valuable in discerning trends that may lead to testable hypotheses. Exploratory data analysis was conducted using the Statistical Analysis System (SAS, 1990). One-way analysis of variance of ranked data was conducted to determine differences across flood-plain basins (that is, Upper, Valley Wall, Middle, and Lower) for the following community endpoints: total # waterbirds, total # ducks, # geese, # herons, # shorebirds, # mallards, # wood ducks, and # blue-winged teal. Other individual species trends were not evaluated because of the rarity of occurrence. Additional attempts were made to test for associations of birds with various wetland types. However, these analyses proved problematic due to lack of interspersion of potential wetland types and current lack of a wetland classification system for such a dynamic system. Statistical significance levels were maintained at $p \leq 0.05$.

Results and Discussion

Hydrologic dynamics

Hydrologic regimes were defined as three separate intervals: pre-flood (March 15–April 13); flood (April 16–May 18); and post-flood (May 21–May 28). River levels prior to the spring flood averaged approximately 15 ft (184 m above mean sea level) at the Boonville gaging station (fig. 6-3). River levels rose to approximately 30 ft at Boonville on April 18th at the initiation of the spring flood. Water levels of selected wetlands are provided in figures 6-3 and 6-4 to demonstrate the effect of river stage and localized rainfall on wetland hydrologic dynamics. Prior to the flood there was water present in Wetlands 2, 3, 5, 22, and 26 that are largely deeper scour wetlands. Water levels increased immediately prior to the flood in Wetlands 10, 11, and 12 due to the combined influence of increasing river stage (via groundwater) and rainfall. Rainfall had a lesser influence on water levels in wetlands and primarily augmented levels in valley-wall wetlands (fig. 6-4). Following the recession of the flood (May 21 and thereafter) water levels decreased within individual wetlands depending on topography, soil characteristics and evaporation. However, the relative significance of these factors for individual basins and wetlands are still not totally understood.

Waterbird community composition

Thirty-one species of waterbirds, totaling 1518 individuals, were observed over the 10-wk period (tables 6-2, 6-3 and 6-4). The waterbird community was composed of ducks (1025), geese (203), herons (85), shorebirds (79), coots (63), cormorants (34), gulls (11), mergansers (8), terns (3), kingfishers (3), sora rails (2), and a grebe (1) (fig. 6-5). Helmers and others (1999) evaluated waterbird species composition across a 4-year period (1994-1997) at Lisbon Bottom and documented 35 species of waterbirds. The species composition of our study was similar to Humburg and Burke (1999) with notable exceptions. For example, in our study we observed both a least bittern and American bittern whereas these species were not noted by Helmers and others (1999). In contrast, Helmers and others (1999) observed more shorebird species (American avocet, American golden plover, and black-bellied plover) and gull/tern species (Franklin's gull, herring gull; Caspian tern, common tern, and least tern) than in our study. However, there were distinct differences in the sampling frequency of our studies. Our study was a 10-week, intensive study of a diversity of wetland types, whereas Helmers and others (1999) conducted a long-term study of selected habitats. Therefore, direct comparisons should be made with caution. The two studies fully illustrate, however, that Lisbon Bottom is host to a large diversity of waterbirds over the course of a year.

Chronology and spatial distribution of waterbird observations

Chronology of waterbird use of Lisbon Bottom was primarily related to spring migration of each species as opposed to the onset and duration of flooding (fig. 6-6; table 6-3). For example, highest numbers of total ducks and geese were observed prior to the flood period which began on April 16, whereas herons and shorebirds exhibited differential migration patterns that varied distinctly by species (fig. 6-6, table 6-3). Major migrations of mallard and scaup occurred during the period of March 16 to April 3 (table 6-3; fig. 6-7). Similar patterns of waterbird migration in the Lower Missouri River Basin were observed by Humburg and others (1999) in their post-flood evaluation studies.

Blue-winged teal (396) (fig. 6-8) were the most commonly observed duck followed by lesser scaup (185), wood ducks (160), and mallards (126). Blue-winged teal were most commonly observed during the flood period of April 16-May 18 (fig. 6-7, table 6-3); however, this period corresponds with historic observations of migration chronology and therefore may not merely be associated with the onset of flooding (Taylor, 1977). Wood ducks were present during the entire study at lower numbers due to their use of the Lower Missouri River for courting, nesting and recruitment (Drobney and Fredrickson, 1977).

Large numbers of waterbirds were observed using the chute and river habitat over the course of the study, with peak numbers being observed in early April due to large numbers of scaup (fig. 6-7 and fig. 6-9). Waterbird use of the flood plain increased with increasing rainfall and flooding as flooded bottomland habitat increased (fig. 6-9).

Similarly, a wide diversity of waterbirds was observed in the chute (20 species) and main river habitats (13 species) (table 6-4); however, much of this use was a single day by species that used these habitats as short stopovers during migration (for example, scaup, ring-necked ducks, snow geese, terns, and gulls) (table 6-3). Highest species richness (23 species) occurred in flood-plain basin wetlands composed of a diversity of wetland types ranging from shallow, seasonal wetlands to deep scours; furthermore, birds that tended to use internal wetlands remained in these areas over a longer period of time compared to birds that used chute and river habitats (table 6-3).

Relative use of flood-plain wetlands (but not including river and chute habitats) was evaluated using analysis of variance of ranked data by basin. Results indicated that total number of waterbirds ($p = 0.037$) and total number of ducks ($p = 0.011$) were significantly higher for the Valley Wall Basin compared to other basins. Wood ducks exhibited greater use of the Upper and Valley Wall basins compared to the Middle or Lower basins. Blue-winged teal had a high use of both Valley Wall and the Lower basins but differences were not statistically different ($p = 0.056$). No significant relationships were observed for species richness, other species, or waterbird groups. Interpretation of such analyses, however, must be approached with caution. Although rank analysis is widely accepted for biological data, the classification of basins may in part reflect the type of wetlands within basins. For example, the majority of wetlands along the valley wall are shallow, seasonal wetlands with increased levels of coarse organic matter (fig. 6-10 and fig. 6-11). In contrast, wetlands in Basin 3, which exhibited less bird use, are typified by deeper scours with little emergent or submergent vegetation. Basins were selected based on location, which is influenced by hydrologic (for example, water source, timing), physical (soils type and morphology), and resulting biological (for example, vegetative biomass and species composition) factors. Classification of wetland types in such a dynamic geomorphic and hydrologic area is an emerging area of wetland ecology that deserves further study.

Blue-winged teal (396 total individuals) were the most frequently observed waterbird observed during the study (table 6-2, table 6-4, and fig. 6-7). Blue-winged teal extensively used Wetland 11, which accounted for 59% of all observations of the species. Wetland 11 consists of a long, shallow (mean 10 cm depth; maximum 1.0 m depth) seasonal wetland that is hydrologically fed from valley-wall tributaries and is extensively vegetated (see Chapter 1). High numbers of blue-winged teal were also observed in Wetland S-14, which consists of a large scour in the Lower Basin with intermittent connectance to the river.

Taylor (1977) conducted the most intensive study of spring ecology of blue-winged teal in Missouri wetlands. Blue-winged teal were observed to use average depths ranging from 13-19 cm in depth (Taylor, 1977). Crop samples of blue-winged teal collected during the period March 17- May 5, 1976 at the Mingo National Wildlife Refuge (Stoddard and Wayne counties of Southeast Missouri) contained approximately 65% animal matter and 35% plant matter. Primary animal matter in the diet consisted of snails (24%) (fig. 6-11), insects (22%; primarily chironomid larvae), and crustaceans (13%; primarily isopods); snails and chironomids were selectively fed upon at greater rates than occurred spatially in the environment. Primary plant materials consisted of seeds (elm *Ulmus* spp. and *Eleocharis* spp.), grass fragments, and algae. Future studies of waterfowl/wetland interactions at Lisbon Bottom should include Wetland 11 for intensive assessment of invertebrate, vegetation, and waterfowl relationships.

Humburg and others (1999) conducted an extensive, multi-year (1994-1998) study of waterbird use of the Lower Missouri River following the Great Flood of 1993 at approximately 140 sites distributed among 4 habitat types (scour connected, scour non-connected, remnant, and temporary) between Hartsburg, MO and Sioux City, IA. Over 70 species of waterbirds were observed. Remnant sites were used more frequently than either of the other three habitat types, however, no single habitat type accounted for all species observed. They concluded that a diversity of habitat types is necessary for the conservation of migratory waterbirds in the Lower Missouri River (Humburg and others, 1999).

Lisbon Bottom and the other tracts of the Big Muddy National Fish and Wildlife Refuge collectively represent a major contributor to the overall habitat diversity of the Lower Missouri River. Prior to the Great Flood of 1993, the majority of waterbird management emphasis was on actively managed areas associated with State Conservation Areas and National Wildlife Refuges. Actively managed wetlands are usually manipulated to produce hydrologic conditions that optimize vegetative composition, food production and availability, and other desired habitat characteristics such as mudflats (that is, for shorebirds). However, to date there have been no published studies to directly compare bird use at passively managed areas of the Big Muddy NFWR with other, more actively managed conservation areas such as Eagle Bluffs or Grand Pass Conservation Areas. Bird use at passively managed and actively managed areas may likely be different than that at Lisbon Bottom or other passively managed areas due to differences in landform, vegetation (type, density, diversity, and height), and hydrology (timing, frequency, and duration of flooding). However, these factors are highly inter-related and complex and therefore require further study to elucidate causal mechanisms. Other bird species, such as warblers and neotropical migrants may actually prefer passively managed habitats such as Lisbon Bottom; however, these groups were not the focus of this study.

This study documented the frequent waterbird use of the chute and the interior flood-plain wetlands located along the valley-wall tributaries located at Lisbon Bottom. The chute habitat was frequently used by unique groups such as terns, gulls, and other species during migration. The chute habitat, with numerous sandbars, shallow habitats, and potential fish and invertebrate food resources, may represent valuable resting areas for waterbirds during migratory flights. Valley-wall wetlands, fed by intermittent streams, were also preferred by many species; many of these species, including blue-winged teal, wood ducks, and mallards, tended to remain for longer periods during migration. These wetlands contain characteristics (that is, shallow water and vegetation) that produce optimum invertebrate food resources and feeding conditions for these dabbling ducks. Collectively, we feel that this information provides some insight into the value of passively managed areas for waterbirds during spring migration. It is hoped that this information, along with future studies of other avian fauna, can be used by refuge staff in the development of an adaptive management framework for Lisbon Bottom and other parcels within the Big Muddy National Fish and Wildlife Refuge.

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List of Tables and Figures

Tables

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Table 6-1. List of basins, wetlands, wetland category, and hydrologic sources used for intensive studies of bird use in relation to physical, chemical, and biological variables.

Basin	Wetland	Morphology	Dominant hydrologic sources
Upper	1	Deep	River topflood
Upper	2	Shallow	Mixed stream/river topflood
Upper	3	Shallow	Mixed stream/river topflood
Upper	4	Deep	River topflood
Upper	5	Deep	River topflood
Upper	7	Shallow	River topflood
Valley Wall	8	Shallow	Mixed stream/river
Valley Wall	9	Shallow	Mixed stream/river
Valley Wall	10	Shallow	Mixed stream/river
Valley Wall	11	Shallow	Stream
Valley Wall	12	Deep	Stream
Valley Wall	22	Shallow	River backflood
Middle	13	Deep	Chute/river
Middle	15	Deep	Chute/river
Middle	16	Deep	Chute/river
Middle	19	Deep	Chute/river
Middle	20	Deep	Chute/river
Middle	21	Deep	River backflood
Lower	23	Deep	Mixed stream/river
Lower	24	Deep	Mixed stream/river
Lower	26	Deep	River backflood
Lower	28	Shallow	River backflood
Lower	29	Deep	River backflood
Lower	30	Deep	River backflood
Lower	S-14	Shallow	River backflood

Table 6-2. List of waterbird species observed at Lisbon Bottom during Initial Biotic Survey (1994-1997; Humburg and Burke, 1999) and during present study (1999). The "+" indicates that the species was observed in a given year. The "-" indicates that the species was not observed in a given year.

Family	Common Name	Species	1994	1995	1996	1997	1999
Anatidae	American wigeon	*Anas americana*	-	+	-	-	-
	Blue-winged teal	*Anas discors*	+	+	+	+	+
	Canada goose	*Branta canadensis*	+	+	+	+	+
	Common merganser	*Mergus merganser*	-	+	-	-	+
	Gadwall	*Anas strepera*	-	+	+	+	+
	Green-winged teal	*Anas crecca*	+	+	+	+	+
	Hooded merganser	*Lophodytes cucullatus*	-	-	-	-	+
	Lesser scaup	*Aythya affinis*	-	+	-	+	+
	Mallard	*Anas platyrhynchos*	+	+	+	+	+
	Northern pintail	*Anas acuta*	+	+	-	-	+
	Northern shoveler	*Anas clypeata*	+	+	+	+	+
	Ring-necked duck	*Aythya collaris*	-	-	-	-	+
	Snow goose	*Chen caerulescens*	-	-	-	-	+
	Wood duck	*Aix sponsa*	+	-	+	+	+
Ardeidae	American bittern	*Botaurus lentiginosus*	-	-	-	-	+
	Black-crowned night heron	*Nycticorax nycticorax*	-	-	-	+	+
	Great blue heron	*Ardea herodias*	+	+	+	+	+
	Great egret	*Ardea alba*	+	+	+	-	+
	Green heron	*Butorides virescens*	+	-	-	-	+
	Least bittern	*Ixobrychus exilis*	-	-	-	-	+
Cerylidae	Belted kingfisher	*Ceryle alcyon*	-	+	+	+	+
Charadriidae	American avocet	*Recurvirostra americana*	+	-	-	-	-
	American golden-plover	*Pluvialis dominica*	+	-	-	-	-
	Black-bellied plover	*Pluvialis squatorola*	-	+	+	-	-
	Killdeer	*Charadrius vociferus*	+	+	+	+	+
	Semipalmated plover	*Charadrius semipalmatus*	+	+	+	+	-
Laridae	Black tern	*Chlidonias niger*	-	+	+	-	+
	Bonaparte's gull	*Larus philadelphia*	-	-	+	-	+
	Caspian tern	*Sterna caspia*	-	-	-	+	-
	Common tern	*Sterna hirundo*	-	+	-	+	-
	Franklin's gull	*Larus pipixcan*	-	-	+	-	-
	Herring gull	*Larus argentatus*	+	-	-	-	-
	Least tern	*Sterna antillarum*	-	-	+	+	-
	Ring-billed gull	*Larus delawarensis*	-	+	+	+	+
Pelecanidae	American white pelican	*Pelecanus erythrorhynchos*	+	+	-	+	-
Phalacrocoracidae	Double-crested cormorant	*Phalacrocorax auritus*	+	+	+	+	+
Podicipedidae	Pied-billed grebe	*Podilymbus podiceps*	-	+	+	-	+
Rallidae	American coot	*Fulica americana*	-	+	+	+	+
	Sora	*Porzana carolina*	-	-	-	+	+
	Virginia rail	*Rallus limicola*	-	-	-	+	-

Table 6-3. Number of individuals of each species counted on each survey date (March 16 to May 28, 1999) at Lisbon Bottom.

		Pre-Flood								Flood										Post-Flood				
Species	**Group**	Mar 16	Mar 19	Mar 26	Mar 30	Apr 2	Apr 6	Apr 9	Apr 13	Apr 16	Apr 20	Apr 23	Apr 27	Apr 30	May 5	May 7	May 11	May 14	May 18	May 21	May 25	May 28	**Sum**	**Days Sighted**
American bittern	Heron													1									1	1
American coot	Rail	1				38		1	9		3	9	2										63	7
Belted kingfisher	Kingfisher			1		1											1						3	3
Black tern	Tern																	3					3	1
Black-crowned night heron	Heron																			1			1	1
Blue-winged teal	Duck				2	44		13	12	23	67	92	95	20	9	7	1	5	2		4		396	15
Bonaparte's gull	Gull	1																					1	1
Canada goose	Geese	2			14	2	14	6	5	2	2		13						1			2	63	11
Common merganser	Merganser	1	5			1																	7	3
Common snipe	Shorebird			6	6			1	1														14	4
Doubled-crested cormorant	Cormorant						2	30	1				1										34	4
Gadwall	Duck	1				10			10				4										25	4
Great blue heron	Heron	3		2	1	4	3	4	7	2	3	4	2	4	1	1	5	1	10	10	7	5	79	20
Great egret	Heron					1		2															3	2
Green heron	Heron																				1		1	1
Green-winged teal	Duck		1	5	8	71	2																87	5
Hooded merganser	Merganser		1																				1	1
Killdeer	Shorebird	3	2	13	2	5	4		4				1							4	2	1	41	11
Least bittern	Heron																	1					1	1
Lesser scaup	Duck			8	7	168		2															185	5
Lesser yellowlegs	Shorebird		1						1			2	2			12							18	4
Mallard	Duck	34	29	16	13	8	4	2	4		2		6				2	3	1		2		126	13
Northern pintail	Duck					1																	1	1
Northern shoveler	Duck					41		1	2														44	3
Pied-billed grebe	Grebe												1										1	1
Ring-billed gull	Gull	1		4				5															10	3
Ring-necked duck	Duck													1									1	1
Snow goose	Geese			140																			140	1
Solitary sandpiper	Shorebird												2		3		1						6	3
Sora	Rail													1				1					2	2
Wood duck	Duck	7	7	9	24	14	10	7	8	10	8	7	9	1	6	8	1	1		1	9	13	160	20
Birds/d		54	46	204	77	409	39	74	64	37	85	114	138	28	19	28	11	15	14	16	25	21	**1518**	
Species/d		9	7	10	9	15	7	12	12	4	6	5	12	6	4	4	6	7	4	4	6	4		

Table 6-4. Numbers of waterbirds by species and wetland observed at Lisbon Bottom, Spring 1999.

		Basin																											
		Upper						Valley-wall						Middle					Lower								Chute	River	Total
		Wetland																											
Common Name	**Group**	**1**	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**22**	**13**	**15**	**16**	**19**	**20**	**21**	**23**	**24**	**26**	**28**	**29**	**30**	**S-14**			
American bittern	Heron								1																				**1**
American coot	Rail		1			1															1	5				4	41	10	**63**
Belted kingfisher	Kingfisher				1							1															1		**3**
Black tern	Tern																										3		**3**
Black-crowned night heron	Heron												1																**1**
Blue-winged teal	Duck	2	4	4	1			6	16		234	7	20	4		2			4		8	14		5		38	26	1	**396**
Bonaparte's gull	Gull																										1		**1**
Canada goose	Geese			6							2		13										18			2	19	3	**63**
Common merganser	Merganser																										7		**7**
Common snipe	Shorebird										13				1														**14**
Double-crested cormorant	Cormorant								1																		33		**34**
Gadwall	Duck								2		2	1															10	10	**25**
Great blue heron	Heron		1		3	3	1	3	4		3	8	8	1	4		3		2	1		8	1		3	5	10	7	**79**
Great egret	Heron																											3	**3**
Green heron	Heron																										1		**1**
Green-winged teal	Duck				5	1																				26	52	3	**87**
Hooded merganser	Merganser																										1		**1**
Killdeer	Shorebird										15		1		7											7	8	3	**41**
Least bittern	Heron										1																		**1**
Lesser scaup	Duck										2			8													8	167	**185**
Lesser yellowlegs	Shorebird										14					2										1	1		**18**
Mallard	Duck				2				3		35	42	10	2	4		1		2							16	9		**126**
Northern pintail	Duck																											1	**1**
Northern shoveler	Duck																									1	25	18	**44**
Pied-billed grebe	Grebe																					1							**1**
Ring-billed gull	Gull													3													6	1	**10**
Ring-necked duck	Duck										1																		**1**
Snow goose	Geese																										140		**140**
Solitary sandpiper	Shorebird								2		1						1						2						**6**
Sora	Rail								2																				**2**
Wood duck	Duck	1	4	8	3	26	3	26	2	11	14	27	12					2	1		2	12	4					2	**160**
Total birds / wetland		**3**	**10**	**18**	**15**	**31**	**4**	**35**	**33**	**11**	**337**	**86**	**65**	**18**	**16**	**4**	**5**	**2**	**9**	**1**	**11**	**40**	**25**	**5**	**3**	**100**	**402**	**229**	**1518**
Total species / wetland		**2**	**4**	**3**	**6**	**4**	**2**	**3**	**9**	**1**	**13**	**6**	**7**	**5**	**4**	**2**	**3**	**1**	**4**	**1**	**3**	**5**	**4**	**1**	**1**	**9**	**20**	**13**	**136**

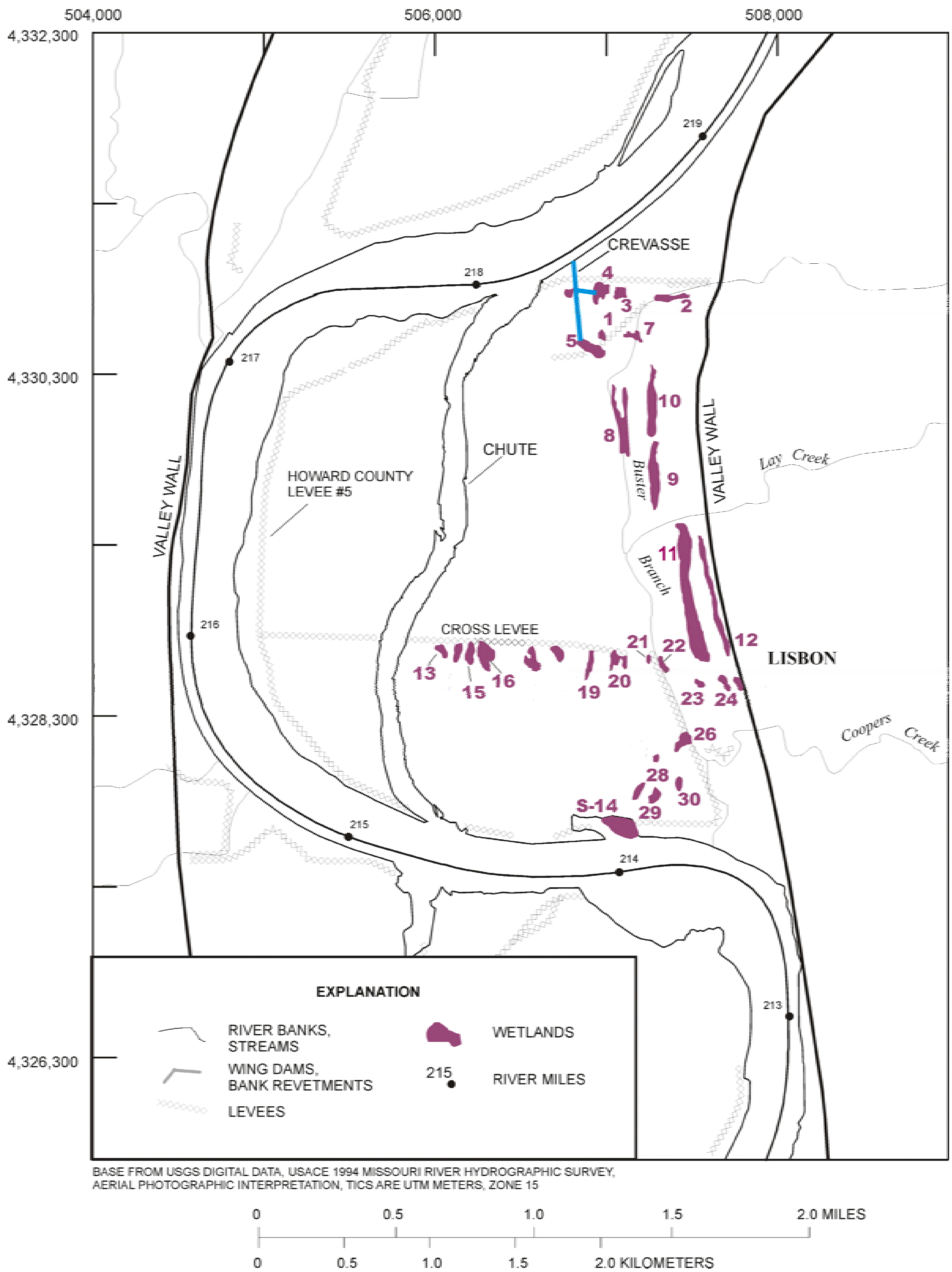

Figure 6-1. Map of Lisbon Bottom wetlands surveyed during the waterbird study, Spring 1999. Refer to table 6-1 for basin assignment of wetlands.

Figure 6-2. Observation of a flood-plain wetland along the survey route at Lisbon Bottom.

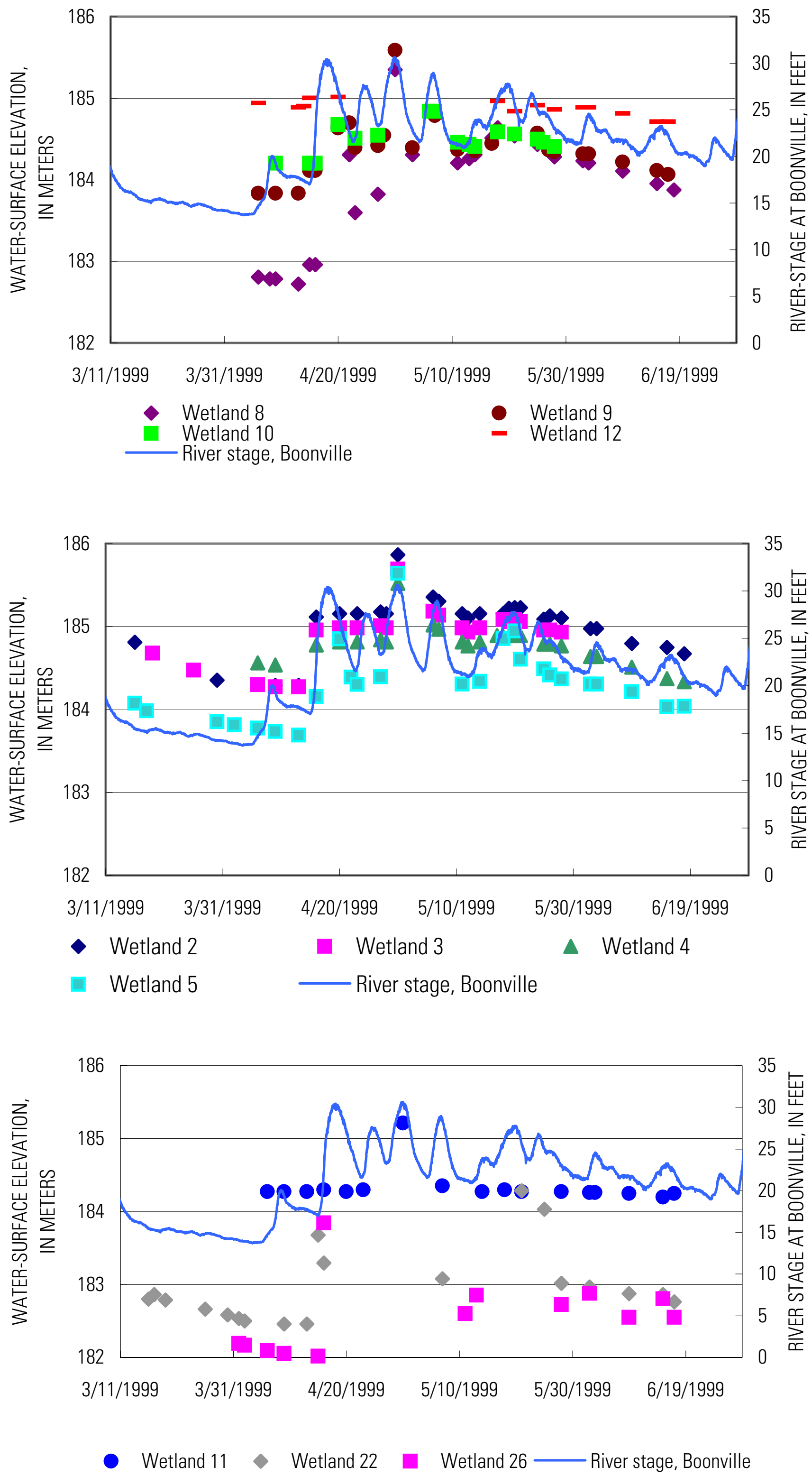

Figure 6-3. Comparison of water surface elevations in selected wetlands observed at Lisbon Bottom, Spring 1999.

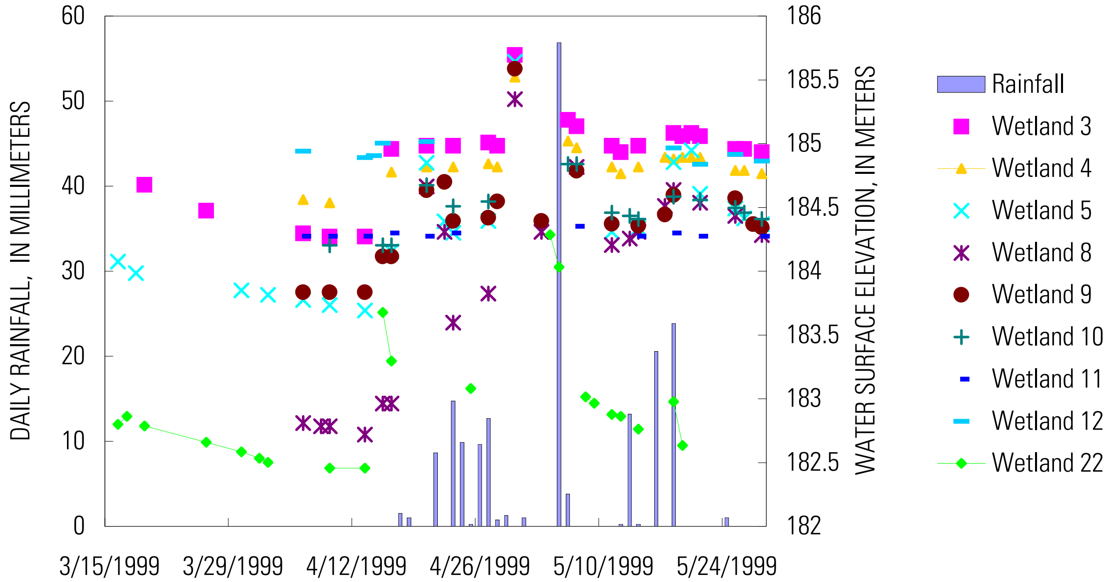

Figure 6-4. Comparison of water levels in individual wetlands compared to rainfall at Lisbon Bottom in Spring 1999.

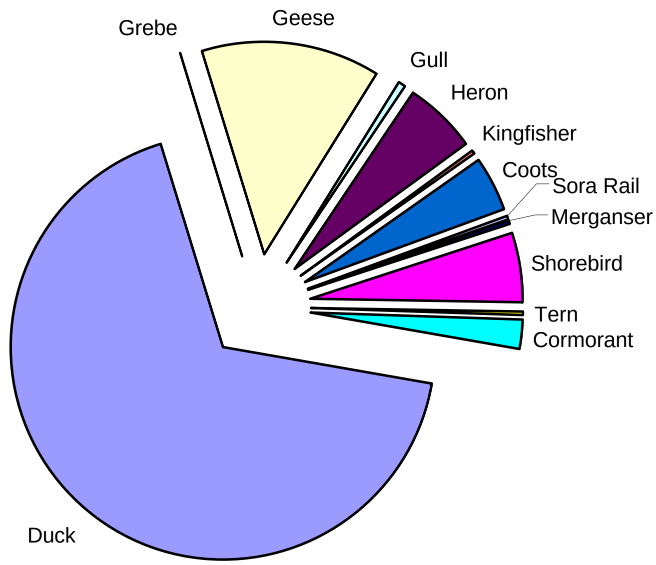

Figure 6-5. Pie chart of waterbirds by group observed at Lisbon Bottom, Spring 1999. Refer to table 6-2 for a list of species within each group.

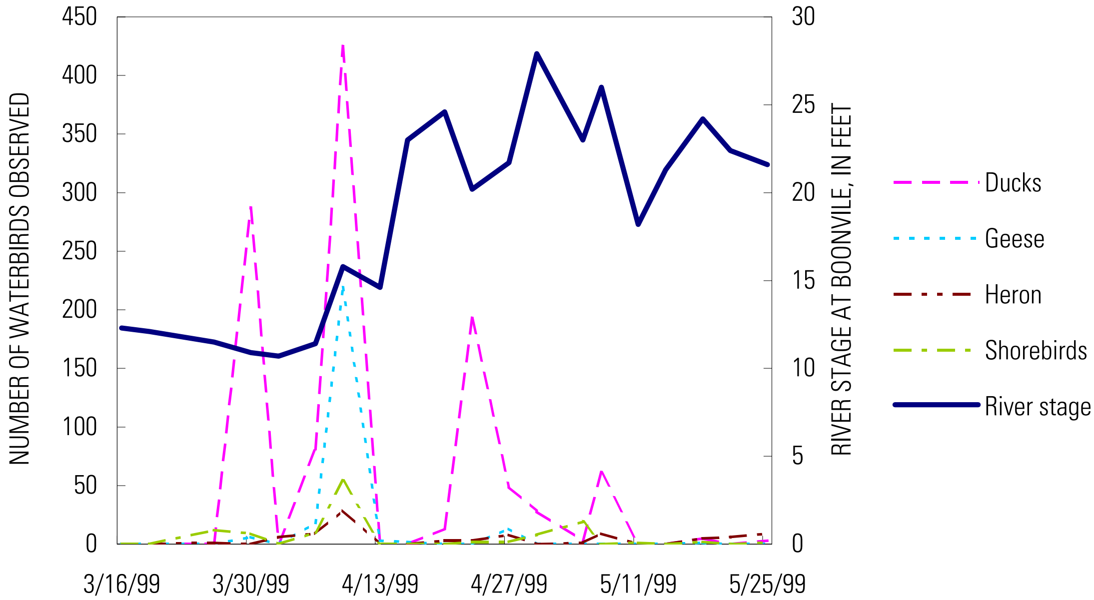

Figure 6-6. Chronology of waterbirds by group observed at Lisbon Bottom, Spring 1999.

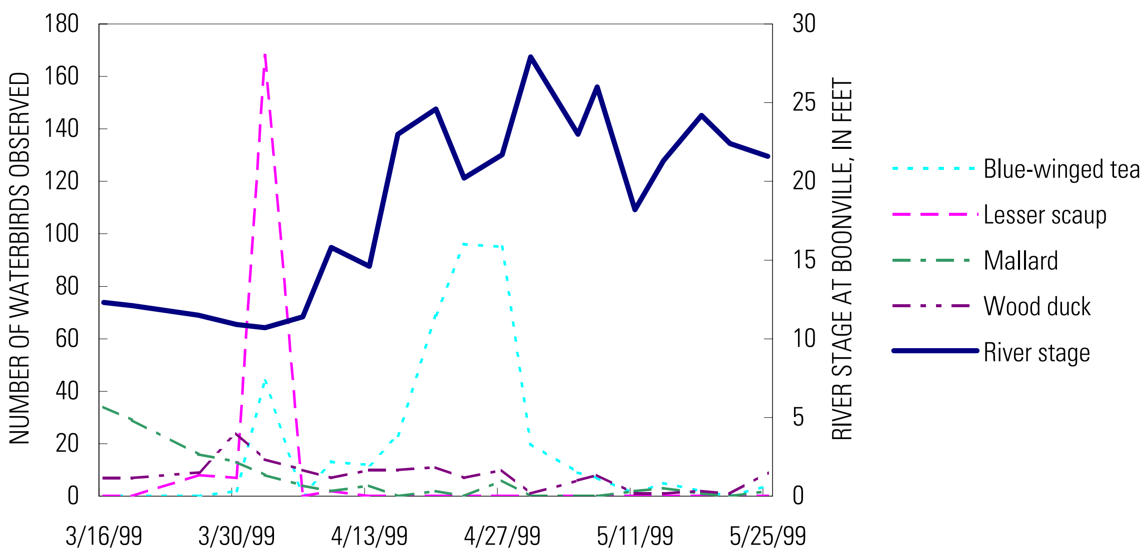

Figure 6-7. Chronology of duck numbers by species observed at Lisbon Bottom, Spring 1999.

Figure 6-8. Blue-winged teal, the most commonly observed duck during the Lisbon Bottom Spring 1999 study (*USGS photo*).

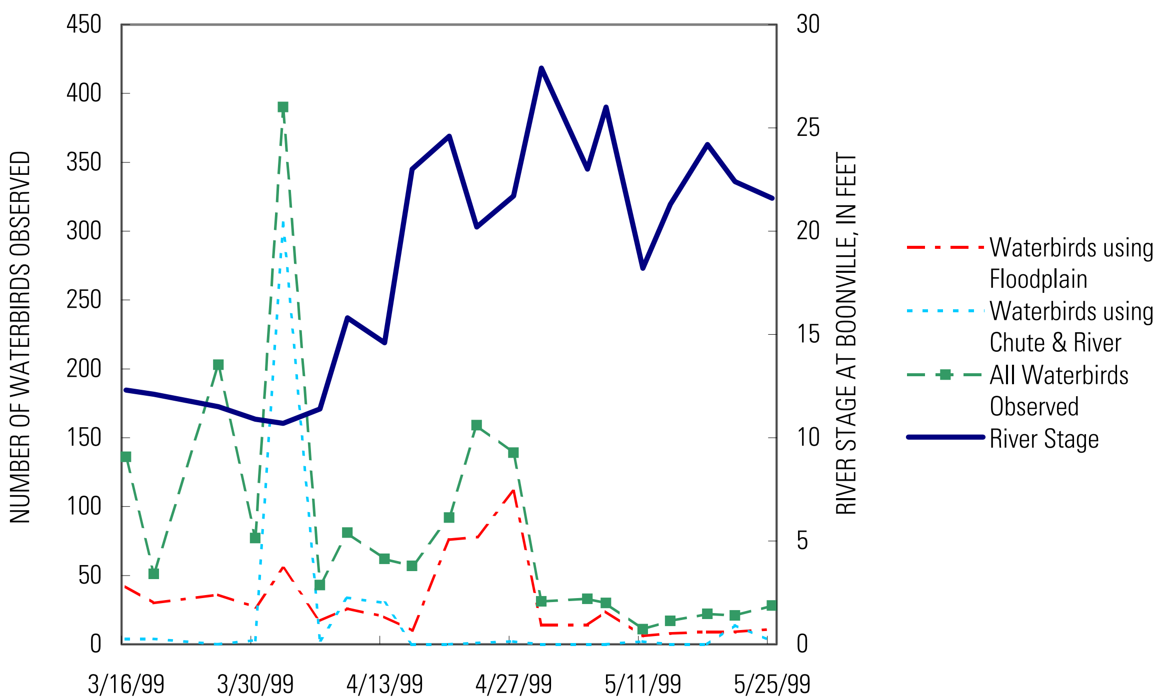

Figure 6-9. Comparison of relative habitat use by waterbirds over the duration of the study at Lisbon Bottom, Spring 1999.

Figure 6-10. Valley-wall wetland at Lisbon Bottom, Spring 1999. Valley-wall wetlands contained high numbers of invertebrates and organic matter that are important ecologically.

Figure 6-11. Snails observed in a valley-wall wetland at Lisbon Bottom. Invertebrate biomass was high in these shallow, vegetated wetlands.